HARSHAW BICRON RADIATION MEASUREMENT PRODUCTS

FRISK-TECH RATEMETER

User's Manual

Publication No. 1054-1-U-0294-002

* * * Release Date * * *

February 9, 1994

Part No. 1054901

Bicron
Saint-Gobain/Norton Industrial Ceramics Corporation
6801 Cochran Road • Solon, Ohio, U.S.A. 44139
1-800-472-5656 1-216-248-7400

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FOREWORD

This manual provides the basic installation, operation, and maintenance procedures for the Bicron Frisk-tech Count-Rate Meter.

Section 1.0 Introduction provides a general description of the instrument and its operation, and a detailed listing of its physical and performance specifications.

Section 2.0 Power Requirements describes both the AC power and battery requirements, and the procedure for fuse replacement.

Section 3.0 Controls describes the various control functions on the instrument.

4.0 Connectors
This section describes all the connectors on the instrument.

Section 5.0 Radiation Measurement describes how to use the instrument.

Section 6.0 Circuit Description provides a brief description of the three electronic circuits that make up the instrument.

Section 7.0 Calibration provides directions for calibration of the instrument.

The **Appendices** are: A) QC Acceptance Procedure, which includes calibration procedures, B) a complete spare parts list so instruments can be repaired on-site, and C) schematic and pictorial drawings to facilitate repair procedures.

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STANDARD WARRANTY

Instruments and options manufactured by Bicron are warranted against defects in materials and workmanship for a period of two years from the date of shipment, unless otherwise agreed upon by Bicron and the customer.

Bicron's obligation with regard to such products shall be limited to repair or replacement, FOB Bicron factory or authorized repair station, at Bicron's option.

The calibration (when applicable) for each instrument is warranted to be within its specified accuracy at the time of shipment. If this initial calibration is determined to be in error, the instrument will be recalibrated at no charge, provided it is returned as described above.

EXCLUSION OF WARRANTY

The aforesaid warranty does not cover instruments, options or probes that are subject to excessive physical abuse or are used for purposes other than those intended. In no event shall Bicron be liable for consequential or special damages, transportation, installation, adjustment, work done by the customer or other expenses that may arise in connection with such defective product or parts.

There are no warranties, express or implied, including without limitation any implied warranty of merchantability or fitness, which extend beyond the description of the face hereof. This express warranty excludes coverage of and does not provide relief for incidental or consequential damages of any kind or nature, including, but not limited to loss of use, loss of sales, or inconvenience. The exclusive remedy of the purchaser is limited to repair, recalibration, or replacement of the instrument at Bicron's option.

This warranty specifically excludes the following items which are covered by their original manufactures' warranties: photomultiplier tubes, GM and proportional tubes, crystal and other solid-state detectors, and batteries.

PROCEDURES and CAUTIONS

The equipment herein described is designed and manufactured in compliance with all applicable safety standards. Nevertheless, certain hazards are inherent in the use of electronic and radiometric equipment.

Adequate warnings are included in this manual and on the product itself to cover hazards that may be encountered in normal use and servicing of this equipment. No other procedures are warranted by Bicron.

It shall be the owner's or user's responsibility to ensure that the procedures and cautionary notes are heeded.

Failure on the part of the user in any way to follow the prescribed procedures shall absolve Bicron and its agents from any resulting liability.

This instrument is intended solely for the detection and measurement of ionizing radiation. It should be used only by persons who have been trained in the proper interpretation of its readings and the appropriate safety procedures that should be followed in the presence of radiation.

All instructions and warnings contained in this manual or on the instrument must be read before use and must be strictly followed. Failure to follow these instructions and warnings may result in inaccurate readings and/or user hazard.

Indicated battery and other operations tests must be performed prior to each use to assure that the instrument is functioning properly.

CAUTION

FAILURE TO CONDUCT PERIODIC PERFORMANCE TESTS IN ACCORDANCE WITH ANSI N323-1978, PARAGRAPHS 4.6 AND 5.4, AND TO KEEP RECORDS THEREOF IN ACCORDANCE WITH PARAGRAPH 4.5 OF THE SAME STANDARD, COULD RESULT IN ERRONEOUS READING OF POTENTIAL DANGER. ANSI N323-1978 BECOMES, BY THIS REFERENCE, A PART OF THIS OPERATING PROCEDURE.

INSPECTION

Instruments should be examined and tested as soon as received. Claims for transportation damages, if any, should be filed at once with the delivery carrier.

1.0 Introduction

1.1 General Description

The Frisk-tech Ratemeter with digital scaler option is a versatile, alarming, count-rate meter designed for use with GM (Geiger-Mueller) or scintillation detectors in a wide variety of "frisking" or monitoring applications.

Its adjustable HV with readout on the meter enables the user to interchange GM and scintillation detectors with ease.

The unit features AC or battery operation, a recessed meter movement, MHV probe connector (BNC optional), external high voltage and calibration adjustments, variable response time, adjustable alarming level, and built-in speaker.

1.2 Specifications

Range: 0-500,000 CPM in four linear ranges.

Accuracy: Within 5% of full scale. Within 10% of reading above 20% of full scale.

High Voltage: Adjustable from 400-2000 VDC, with direct readout on the meter. 10 μA of current available through 1500 VDC.

Input Sensitivity: 50 mV into 20 kohms typical.

Response Time: Adjustable from 2 to 20 seconds.

Power Requirements: 105-125 VAC, 50-60 Hz standard (210-250 VAC, 50-60 Hz optional).

Geotropism: Within ±2% of full scale.

Shock: 100g per lightweight machine of MIL-STD 202C, method 202B.

Vibration: 5g in each of three mutually orthogonal axes at one or more frequencies from 10-33 Hz.

AC Indicator: Yellow LED on front panel illuminates whenever the unit is connected to AC power.

Detector: Choice of GM or scintillation probes.

Probe Connector: MHV standard (BNC optional).

Meter: Ruggedized, recessed, high-torque 1 mA meter with 3.35" (8.51 cm) scale marked 0-500 CPM, 0-2.0 kilovolts, and "bat. ok" checkband.

Speaker: Switch selectable to provide an audible "click" for each detector pulse plus an audible alarm, or audible alarm only.

Alarm: Audible, non-latching rate alarm with front panel adjustment from 10% to 130% of full scale and readout on the meter. Red LED ALARM indicator on front panel.

Headphone Jack: 3.5 mm monaural phone jack. Signal (detector pulses) present at all times and not affected by speaker or volume control settings. No alarm signal available.

Recorder Output: A BNC connector provides an analog output signal that correlates to the analog meter. Full scale is approximately 1.3 V. The output will drive 100 kohm loads.

Scaler Output: A BNC connector provides a positive-going pulse for each detector event. Pulse amplitude is approximately 5 V for a 1 megohm load, and 2.5 V for a 10 kohm load.

1.0 Introduction (cont'd)
1.2 Specifications (cont'd)

Digital Scaler Option: six-digit, 0.2" high LCD display mounted inside analog meter. Rear panel three-position scaler count time selection switch (0.1, 1 and 10 minute count times). Front panel meter reset pushbutton switch used to start scaler count time.

Audio Volume: Adjustable when speaker switch is in the "pulse/alarm" position. Does not affect volume when the speaker switch is in the "alarm" position.

Controls: Seven-position ratemeter switch; three-position speaker switch; rotary response and volume adjustments; meter reset pushbutton; power ON/OFF switch.

Reset: Pushbutton switch that quickly zeros the meter on any count rate range.

Battery: Dual six-volt DC, rechargeable gelled cells.

Battery Life: > 50 hours between charges, with check band on the meter.

Battery Recharge: Regulated; automatic whenever unit is connected to AC power.

Recharge Time: 16 hours when batteries have reached the low end of "bat. ok" checkband.

Battery Dependence: Less than 10% change in reading throughout "bat. ok" checkband.

Power Cord Connector: 3-wire IEC-type with integral 1/4 amp fuse. UL and CSA recognized.

Construction: All aluminum case with textured polyurethane paint finish and silkscreened nomenclature.

Probe Holder: Optional holder available for Bicron and competitive probes.

Temperature: Operational from -20°C to +50°C.

Size: 10.0" wide x 5.0" high x 7.8" deep (25.4 x 12.7 x 19.8 cm), including handle.

Weight: 5.1 lbs. (3.3 kg).

2.0 Power Requirements

The Frisk-tech can be operated from two power sources: AC line or battery. The operation of both is explained below.

2.1 AC Power

The AC cord receptacle/fuseholder can be found on the rear panel of the unit. It will accept a standard North American power cord (supplied). The unit is factory-wired for 105-125 VAC, 50-60 Hz operation via selection jumpers mounted on the main circuit board (optional 210-250 VAC factory wiring available).

To convert the unit to 210-250 VAC, 50-60 Hz operation, disconnect the power cord from the unit to guard against electrical shock. Remove the two jumpers on the main circuit board that correspond to 110V operation. Insert one jumper into the location on the main circuit board that corresponds to 220V operation. The jumper locations can be found on the main PCB board component location drawing, Figure 3.

CAUTION

Due to the potential for electrical shock, this modification should be performed only by qualified personnel.

2.2 Battery Power/Recharging

The internal 6 VDC gelled-cell batteries are automatically recharged whenever the unit is connected to the AC line. The charger is both voltage and current regulated. Charging occurs regardless of the state of the power ON/OFF switch.

If the unit is connected to the AC line and the power fails, the batteries, if they have sufficient charge, will automatically take over as the power source for the instrument without interruption.

Fully charged batteries can provide greater than 50 hours of service.

With power off, fully discharged batteries require approximately 16 hours to become fully charged. With power on, the recharge time is longer.

2.0 Power Requirements (cont'd)

2.3 Battery Replacement

Gelled-cell batteries can provide two to four years of service under normal use. A battery which fails to hold sufficient charge, or that cannot be recharged, should be replaced. It is best to replace both batteries at the same time, since the life expectancy of each is about the same.

Battery replacement is as follows:

1. Disconnect the power cord and remove the top cover of the unit.
2. Disconnect the red and black wires from the battery terminals.
3. Loosen the battery retaining clip from the case side wall with a nutdriver (full removal of retaining clip is not necessary).
4. Remove and replace the batteries with two six-volt DC, 1 A-hr NP1-6 (or equivalent) gelled cells.
5. Connect the red wire from the main circuit board to the "+" terminal of one of the batteries.
6. Connect the black wire from the main circuit board to the "-" terminal of the other battery.
7. Connect the small wire with two battery clips on it to the remaining two unused battery terminals.
8. Tighten the battery retainer clip.
9. Replace the top cover and reconnect the power cord.

2.4 Fuse Replacement

Fuse type: BUSS GMA-1/4 or equivalent.

To check or replace a fuse, remove the power cord from the AC cord receptacle. Gently pry out the fuse holder with a small, flatblade screwdriver by rocking the screwdriver back and forth along the bottom slot of the holder.

The holder accommodates two fuses: the rear fuse is the active fuse, the front is a spare. The fuseholder snaps into place by pressing it back into the power cord receptacle.

3.0 Controls

This section describes the various controls and options available to the Frisk-tech user. The controls are all mounted on the front panel, as shown in Figure 1. Most of the adjustments are mounted on the back panel, as shown in Figure 2.

3.1 Ratemeter Control Switch

This switch controls which function is performed by the meter. It has seven positions, as described below.

Alarm Set

In this position, the level at which the alarm will be actuated on all four count-rate ranges is displayed on the analog meter. This level is user-adjustable from 10% to 130% of full scale via the alarm set potentiometer found immediately below the words "Alarm Set". To prevent tampering, the adjustment potentiometer is recessed in the panel. A small, flatblade screwdriver is required for the adjustment.

Bat.

The condition of the internal batteries can be observed when this function is selected. A reading within the "bat. ok" checkband should be observed.

If the unit is not connected to AC power, and the meter reading is low (or below the checkband) the instrument should be connected to AC power to prevent deep battery discharge.

If AC power is present and reading is below the checkband, have the unit serviced by qualified personnel.

If the batteries appear unable to retain a charge, they may require replacement. Refer to Section 2.3 Battery Replacement, which describes this procedure more fully.

CAUTION

Always check the condition of the batteries prior to using the instrument, even if the unit is connected to the AC line. Do not use the instrument if the analog meter does not indicate within the "bat. ok" checkband.

HV

In this position, the detector high voltage is displayed directly on the lower analog meter scale. The high voltage can be varied from 400 to 2000 VDC via the recessed HV adjustment potentiometer, located on the

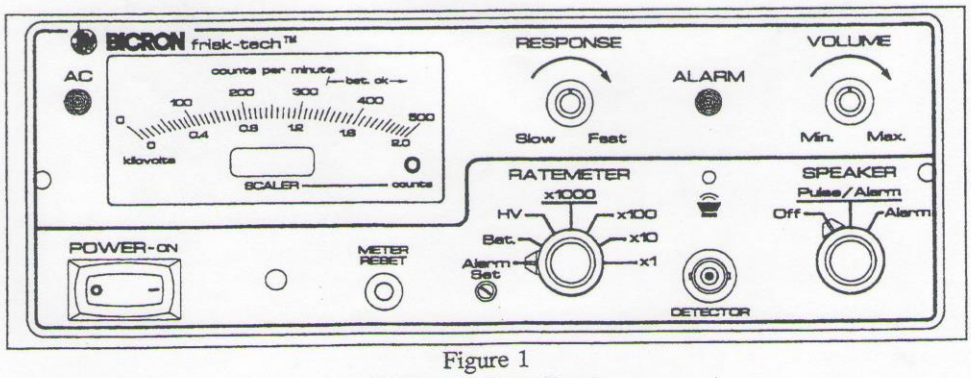

Figure 1
Frisk-tech Front Panel

3.0 Controls (cont'd)
3.1 Ratemeter Control Switch (cont'd)

rear panel (Figure 2). A small, flatblade screwdriver is required for the adjustment.

The standard factory high voltage setting is 900 VDC.

CAUTION

Always check the high voltage level prior to connecting a probe to the instrument. Probe damage and/or erroneous readings may result from high voltage settings that are in excess of the probe manufacturer's specifications.

X1000 through X1

These are the four count rate ranges of the instrument. When taking a reading, be sure to multiply the analog meter reading by the switch setting.

3.2 Speaker Switch

The speaker switch controls the internally mounted speaker.

In the "Off" position, the speaker is silent. Both the pulse and alarm audio functions are disabled.

In the "Pulse/Alarm" position, the speaker provides an audible "click" for each detector event. Whenever the alarm set level is exceeded on any of the four count rate ranges, the clicking is replaced with a full volume continuous tone to indicate that an alarm condition exists.

In the "Alarm" position, the speaker produces a full volume tone only when the alarm set level is exceeded on any of the four count rate ranges. It is silent at all other times.

The speaker function is disabled on the "Alarm Set", "Bat.", and "HV" positions, regardless of the setting of the speaker switch.

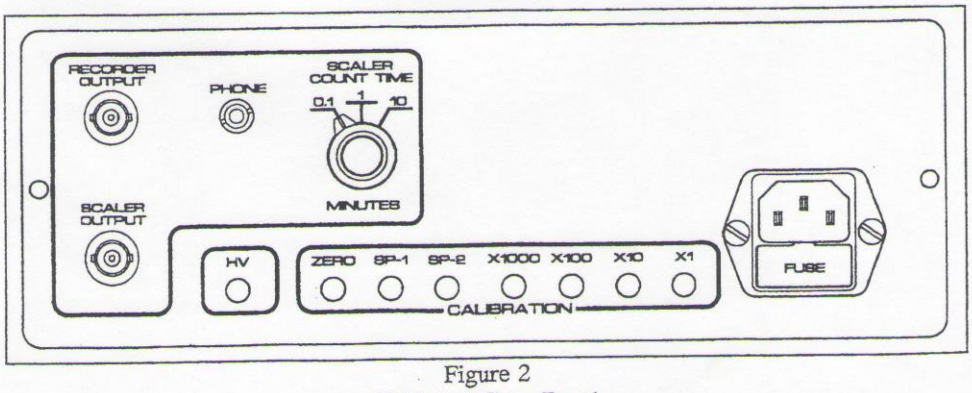

Figure 2
Frisk-tech Rear Panel

3.0 Controls (cont'd)

3.3 Volume Control
This control allows the user to adjust the loudness of the audible "clicking" when the speaker switch is on the "Pulse/Alarm" position. Clockwise rotation increases speaker volume.

The volume control has no effect on the speaker whenever an alarm condition occurs. The speaker provides a full volume, continuous tone in both the "Pulse/Alarm" and "Alarm" positions during the alarm period.

3.4 Alarm LED
This visual indicator illuminates whenever the alarm set point is exceeded on the four count rate ranges, regardless of the speaker switch setting.

As a test, the alarm LED illuminates whenever the ratemeter control switch is in the "Alarm Set", "Bat.", or "HV" positions.

3.5 Response Control
This control provides for a continuously adjustable response time from two to twenty seconds on all four count rate ranges. Full counterclockwise rotation of the control provides a twenty-second response time ("slow"). Full clockwise rotation of the control provides a two-second response time ("fast").

The response control has no effect on the "Alarm Set", "Bat.", or "HV" positions of the ratemeter control switch. The response time for these modes has been preset to less than one second.

3.6 Meter Reset
This pushbutton switch provides rapid meter zeroing. It is typically used whenever a response adjustment is made.

To reset the meter to zero, press the meter reset switch. As long as the switch remains depressed, the meter will remain at zero.

This switch should be used only on the four count rate ranges. When used in the "Alarm set", "Bat.", or "HV" positions, the meter will reset to near zero, and then return to the value that was observed prior to depressing the switch.

3.7 Input Sensitivity Adjustment
The input sensitivity of the unit is factory set to be 50 mV into 20 kohms. No further adjustments are normally required.

The threshold potentiometer R27 (5 kohm), mounted on the main circuit board inside the unit (Figure 3), controls the input sensitivity. It has a range of up to approximately 60 mV, with the lower boundary being determined by inherent electronic noise in the system.

Clockwise rotation of R27 decreases the input sensitivity. To measure the input sensitivity voltage, connect a voltmeter across test points TP1 and TP2, which are located near R27 on the main circuit board inside the unit.

3.8 Digital Scaler Option
The Frisk-tech, when equipped with the digital scaler option, provides a six-digit, count totalizer with three available count time periods: 0.1, 1, and 10 minutes. The scaler features a crystal-controlled timebase for greater accuracy.

3.0 Controls (cont'd)
3.8 Digital Scaler Option (cont'd)

The count totalizer time is selected via the rear panel scaler count time control switch. This three-position switch selects either 0.1, 1, or 10-minute count periods. Note: turn the unit OFF before changing the scaler count time control switch.

To start a count time, press the front panel meter reset pushbutton switch. This switch doubles as the scaler "count" pushbutton switch. The "count" light, located inside the analog meter, will illuminate, indicating that a count is in progress. When the light turns off, the count time has completed.

Once a scaler count is started, the "meter reset" pushbutton is electronically locked out to prevent accidental restarting. If you wish to reset the scaler during a count, simply turn the instrument off for a few seconds, and then back on. Push the "meter reset" button to start a new count.

Note: The analog meter reset function of the meter reset/count pushbutton remains functional during the count period. Only the scaler count function is locked out while the count is in progress.

4.0 Connectors

Detector Connector
The detector connector is an MHV-type (BNC optional) connector.

CAUTION
Always turn the power OFF before removing or connecting a detector.

Recorder Output
This output is located on the rear panel of the unit. It provides an analog output that tracks the analog meter on the front panel. The voltage of the recorder output is approximately 1.3 V for a full-scale meter reading. The output impedance is 10 kohms.

The recorder output is active on all seven ratemeter control switch positions. The connector type is BNC.

Scaler Output
This output is located on the rear panel of the unit. It provides a positive-going logic-type pulse for each detector event. The pulse amplitude is approximately 5.0 V for a 1 megohm load, and 2.5 V for a 10 kohm load. The pulse width is 15 microseconds.

The scaler output is active only when the ratemeter control switch is set to one of the four count rate ranges. The connector type is BNC.

Headphone Output
This output is located on the rear panel of the unit. It provides a pulse for each detector event. The pulse output is designed to drive higher impedance headphones.

The volume control and alarm circuitry have no effects on the headphone output. Only pulses are available, and only when the ratemeter control switch is set to one of the four count rate ranges. The connector is a 3.5mm phone jack.

5.0 Radiation Measurement

This section describes the procedure for making a radiation measurement, including necessary precautions.

1. Select a GM or scintillation probe appropriate to the survey situation. Check the high voltage to see that it is acceptable for the probe to be used. With the power off, connect it to the instrument via the detector connector located on the front panel.

   CAUTION

   Do not exceed the recommended high voltage for the probe in use. The standard factory setting of the high voltage is 900 VDC, and it is suitable for most probes.

2. Turn the selector switch to one of the four count rate ranges (X1000 through X1).

3. Multiply the meter scale reading by the ratemeter control switch multiplier to obtain the reading, in CPM.

   CAUTION

   The type of ionizing radiation used to determine the proper operation of this instrument must be the type the count rate meter and the probe selected were designed to measure.

6.0 Circuit Description

The Bicron Frisk-tech contains two interconnected circuit boards (three, if equipped with digital scaler option). The circuit boards contain several circuit modules, which are discussed below:

Power Supply

This circuitry is located on the main circuit board, mounted to the case bottom of the unit. The power supply is divided into two sections: A +14 VDC voltage and current regulated supply that recharges the gelled-cell batteries, and a +7 and -7 VDC supply that powers the rest of the instrument.

The +14 VDC supply is present whenever the unit is connected to AC power. It recharges the batteries in a way recommended by gelled-cell battery manufacturers.

The +7 and -7 VDC supply is enabled whenever the power ON/OFF switch on the front panel is turned ON.

Both supplies are feedback regulated, and both have thermal and overload protection.

Analog Ratemeter

This circuitry is located on both circuit boards. Most controls are located on the switch printed circuit board that is mounted behind the front panel. The two boards are interconnected via a 24-pin ribbon cable assembly.

The analog ratemeter circuitry contains several sections, as follows:

1. A feedback-regulated, electronically stabilized high voltage module for the detector potential. Additional circuitry provides HV readout on the analog meter scale.

Appendix A

Bicron QC Acceptance Procedure Number 1054931
Model: Frisk-tech with Digital Scaler Option

CAUTION: This procedure should be performed only by qualified personnel since AC line voltage is present inside the unit.

1. Remove the top cover of the instrument. Perform a visual inspection of the finished product.

Note: see Figure 3 for the location of all Circuit Board components not located on the rear panel.

2. Remove the fuseholder from the rear panel. Install a Buss GMA 1/4-amp (or equivalent) fuse in the rear fuse compartment and replace holder.

3. Disconnect the red wire from the "+" terminal of the 6 VDC battery to which it is connected. Turn the power ON/OFF switch on the front panel OFF. Inspect all AC power wiring between the rear panel and the main PC board. Inspect the 110/220 jumper selection on the main board (two jumpers for 110 V; one jumper for 220 V). Connect the unit to AC power via the power cord connector on the rear panel. Perform the following tests and calibrations to the power supply:

   a. Observe the AC power indicator on the left side of the front panel; it should be illuminated. Unplug the power cord from the AC power. Wait for 10 seconds. The AC power indicator should turn off. Reconnect the AC power cord.

   b. Connect a voltmeter between the disconnected red wire and ground (TP9). Turn the power ON/OFF switch ON. Adjust R3 (5 kohm +14 VDC adjustment potentiometer) until the voltmeter reads 13.95 $\pm$0.1 VDC. Disconnect the voltmeter when finished.

   c. Turn the power ON/OFF switch OFF. Connect a fused ammeter between the disconnected red wire and the battery terminal which contains a black wire from the main board. Turn the power ON/OFF switch ON. A reading of 110 $\pm$ 25 mADC should be observed. Disconnect the ammeter when finished.

   d. Leave the power ON/OFF switch ON. Connect a voltmeter between the +7 VDC power supply (TP5) and ground (TP9). A voltage of 7.5 $\pm$ 0.5 VDC should be observed.

   e. Leave the power ON/OFF switch ON. Connect a voltmeter between the -7 VDC power supply (TP7) and ground (TP9). A voltage of -6.7 $\pm$0.5 VDC should be observed.

   f. Turn the power ON/OFF switch OFF. The +7 and -7 VDC supplies should discharge to near 0 VDC. Connect the voltmeter again to the +14 VDC supply (between the red battery wire and ground). A reading approximately 0.2 - 0.6

Appendix A (cont'd)

VDC higher than the value set in 3.b., above, should be observed. This is normal and is due to the batteries having been removed from the circuit. The purpose of this test is to observed that the +14 VDC is present regardless of the state of the power ON/OFF switch.

g. Disconnect all test equipment from the power supplies. Reconnect the red wire to the "+" battery terminal from which it was removed.

h. Turn the power ON/OFF switch ON. Observe that power is reaching the switch board by rotating the ratemeter switch and by noting meter/LED activity. Leave the ratemeter switch in one of the positions that keeps the alarm LED on.

Leave the power ON/OFF switch ON. Remove and reconnect the AC power cord from the unit a few times. After doing this, keep the AC power cord disconnected. The alarm LED should remain on.

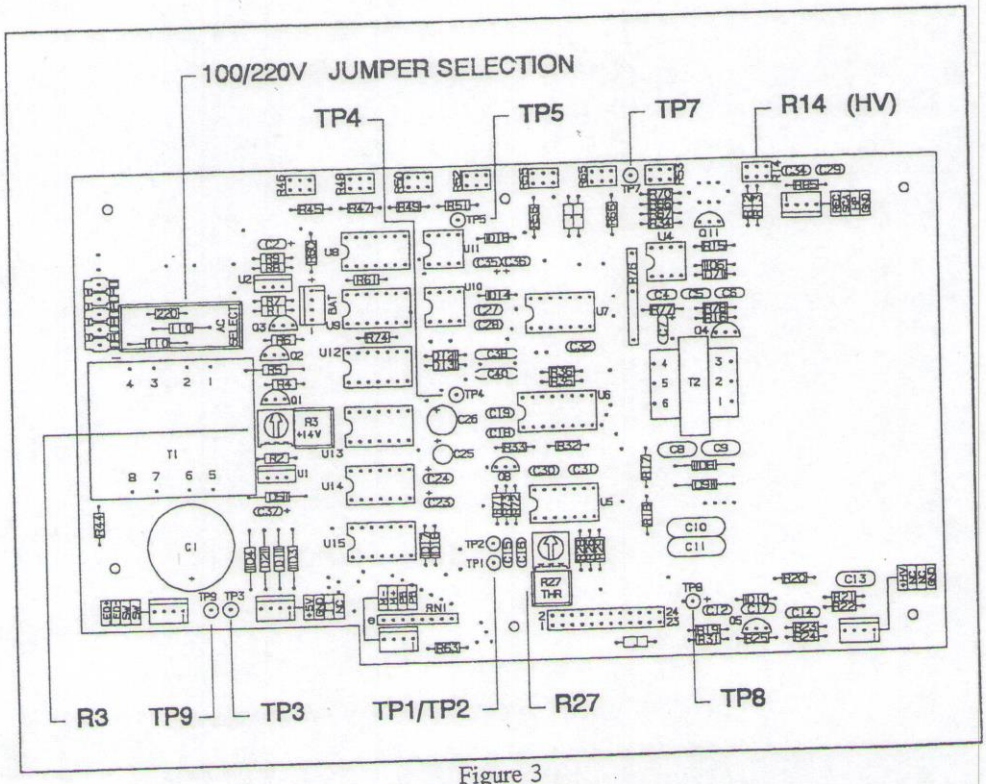

Figure 3
Frisk-tech Main Circuit Board

6.0 Circuit Description (cont'd)

2. A linear charge-pump ratemeter that converts the detector pulses to a count rate reading on the calibrated analog meter scale. Also included is a continuously adjustable response time control, adjustable alarm-set, meter reset, and visual alarm indicator.

3. A speaker section for audible pulse counting and alarm indication. The pulse counting function includes a volume control.

Temperature compensation is used throughout the analog circuit section.

Digital Scaler Option

This option is located on a third circuit board, which is mounted behind the analog meter. It features a digital timebase and digital counting. Controls for this option are located on both the front and rear panels of the unit.

7.0 Calibration

The instrument is calibrated electronically using a variable frequency pulse generator. The calibration potentiometers are located on the rear panel of the instrument.

A detailed calibration procedure is part of the QC Acceptance Procedure in Appendix A. Recalibration is required after servicing, and at intervals which may be specified by regulatory agencies.

Appendix A (cont'd)

This test is to confirm that the batteries automatically take over when AC power is removed from the unit. NOTE: if the batteries are discharged, this test may fail. Recharge the batteries overnight by connecting the unit to AC power, and then repeat the test.

4. If the batteries have a sufficient charge, leave the AC power cord disconnected. Perform the following tests and calibrations to the ratemeter and audio sections:

   a. Turn the power ON/OFF switch OFF. Mechanically zero the analog meter via the zero adjustment screw located on the front panel below the meter.

   b. Turn the power ON/OFF switch ON. Turn the ratemeter control switch to the "X1000" position. Connect a voltmeter between the output of U10 (TP4) and ground (TP9). Adjust R53 (50 kohm ZERO potentiometer, "Zero") until the voltmeter reads 1.0 +5.0/-1.0 mVDC.

   c. Turn the ratemeter control switch to the "HV" position. Connect a high voltage measuring device with an impedance of at least 1000 megohms across the detector connector on the front panel. Using R14 (50 kohm HV adjust potentiometer, "HV"), set the high voltage for a reading of 1000 ± 30 VDC on the voltmeter. Adjust R55 (500 ohm SPAN2 adjust potentiometer, "SP-2") until the analog meter reads 1000 VDC.

      To test linearity, adjust R14 ("HV") until the voltmeter reads 1600 VDC. The analog meter should read 1600 ±160 VDC. Adjust R14 until the voltmeter reads 400 VDC. The analog meter should read 400 ±40 VDC. Adjust R14 until the voltmeter reads 900 ± 27 VDC. This value is the standard calibrated high voltage for a Frisk-tech, and is to be noted on the certificate of calibration. Disconnect the high voltage measuring device when finished.

   d. Turn the ratemeter control switch to the "Bat." position. For fully charged batteries, a meter reading within the "bat. ok" checkband should be observed. NOTE: if the batteries are discharged, this test may fail. Recharge the batteries overnight by connecting the unit to AC power, and then repeat the test.

   e. Turn the ratemeter control switch to the "X1000" position. Adjust the response control for fast response. Turn the speaker switch to the "Alarm" position. Adjust the alarm set potentiometer on the front panel until it points to the 12 o'clock position. Connect a variable frequency pulse generator that is capable of withstanding high voltage at its output across the detector connector on the front panel. (If the pulse generator is not designed to accept high voltage at its output, turn the high voltage off via R14, the 50 kohm HV adjust potentiometer. If this is done, the calibration procedure of 4.c., above, must be repeated when this test is completed.)

Appendix A (cont'd)

Slowly increase the frequency of the pulse generator until the speaker indicates an alarm condition by emitting a loud, continuous tone. Carefully note the exact scale reading at which the alarm condition occurs. Turn the ratemeter control switch to the "Alarm Set" position. Adjust R65 (5 kohm SPAN1 adjust potentiometer, "SP-1") until the analog meter reading is the same as the one noted above.

f. To test linearity, adjust the alarm set potentiometer on the front panel until the analog meter indicates full scale. Turn the ratemeter control switch to the "X1000" position, and slowly increase the frequency of the pulse generator until an alarm condition occurs. Note the reading at which the alarm occurs. It should be within $\pm$ 5% of the alarm set point. Also note that the alarm LED lights whenever an alarm occurs.

Turn the speaker switch to the "Pulse/Alarm" position. The audible alarm should still be enabled. Lower the frequency of the pulse generator until the count rate is below the alarm set point. The audible alarm should switch over to audible pulses, and the alarm LED should turn off.

Turn the volume control fully counterclockwise to the "min." position. The audible pulse tone should decrease in volume. Increase the frequency of the pulse generator so that the alarm condition occurs again. The audible alarm should enable at full volume. Vary the volume control. The audible alarm should not change in volume. Turn the speaker switch to the "Off" position. The audible alarm should stop, but the alarm LED should remain lit. Repeat this test for alarm settings of 50% and 20% of full scale. Each result should yield an alarm condition within 5% of the alarm set point. When finished with this test, the alarm set potentiometer on the front panel should be adjusted for a full scale alarm.

Repeat the above alarm set tests (full scale setting only) and speaker tests for the X100 through X1 ranges.

g. Turn the ratemeter control switch to the "Alarm Set" position. The speaker should be silent, and the alarm LED should illuminate as a lamp test.

Repeat this test for the "Bat." and "HV" ratemeter control switch positions. A "chirp" from the speaker while changing the ratemeter control switch is normal.

h. Leave the pulse generator connected to the detector connector. Turn the ratemeter control switch to the "X1000" position. Turn the speaker switch "Off". Connect a frequency counter with an input impedance greater than 1 megohm across the scaler output on the rear panel. The frequency shown on the frequency counter should be within 5% of the pulse generator frequency.

Appendix A (cont'd)

i. Leave the pulse generator connected to the detector connector. Leave the ratemeter control switch in the "X1000" position. Connect a set of high impedance headphones to the phone output on the rear panel. Observe that the output provides an audible "click" for each pulse generator pulse. If headphones are not available, an oscilloscope can be substituted. Positive-going pulses of an amplitude of 3 VDC (± 20%) and a width of approximately 10 to 15 microseconds for each pulse generator pulse should be observed.

Repeat the above test for the "X100" through "X1" ratemeter control positions.

j. Leave the pulse generator connected to the detector connector. Turn the ratemeter control switch to the "X1000" position. Set the response control for slow response. Adjust the pulse generator so that a reading near full scale is observed. Turn the pulse generator off. The meter should slowly drop back to zero. The response time (0 to 90% of final reading) should be 20 seconds ± 25%. Set the response control for fast response. Turn the pulse generator on until a full scale reading is again observed. Turn the pulse generator off. The meter should quickly drop back to zero. The response time (0 to 90% of final reading) should be 2 seconds ± 50%.

k. Turn the pulse generator back on. Push the "meter reset" switch on the front panel. The meter should quickly zero. Let go of the "meter reset" pushbutton. The meter should return to near full scale.

5. Perform a CPM calibration, as follows:

a. Leave the pulse generator connected to the detector connector. Set the response control midway between fast and slow. Turn the speaker switch to the "Off" position. Turn the ratemeter control switch to the "X1000" position.

b. Adjust the frequency of the pulse generator to the value required to calibrate the unit at 80% of full scale on the analog meter. (Value listed in Table T-1.)

c. Adjust R52 (5 kohm X1000 calibration potentiometer, "X1000") until the analog meter reads 80% of full scale.

d. Readjust the frequency of the pulse generator to the value required to calibrate at 20% of full scale on the analog meter. (Value also listed in Table T-1.)

e. Note the analog meter readings from 5.c. and 5.d., above, on the Certificate of Calibration.

f. Similarly, calibrate the X100 range, using R50 (50 kohm X100 calibration potentiometer, "X100"); the X10 range, using R48 (500 kohm X10 calibration potentiometer, "X10"); and the X1 range, using R46 (5 megohm X1 calibration potentiometer "X1").

6. If the unit is equipped with the digital scaler option, perform the following tests:

Appendix A (cont'd)

a. Leave the pulse generator connected to the detector connector. Connect a frequency counter to Pin 11 of U101 on the digital scaler option circuit board. The frequency should be 32.768 KHz ± 0.1%.

b. Set the digital scaler for a 0.1 minute count time via the rear panel scaler count time switch. Turn the control switch to one of the four count rate ranges. Press the "Meter Reset" pushbutton on the front panel. The "count" indicator inside the analog meter should illuminate. Time the count period; it should be six seconds. The "count" indicator should turn off at the completion of the count period.

c. Set the digital scaler for a one-minute count time via the rear panel scaler count time switch. Turn the control switch to the X10 range. Set the pulse generator to a rate that produces a mid-scale reading (2500 CPM). Press the "Meter Reset" pushbutton on the front panel. At the completion of the one-minute count period, the total on the scaler display should equal the count rate indicated on the analog meter.

7. Set the input sensitivity, as follows:

   Remove the pulse generator from the detector connector. Turn the control switch to the "X1000" position. Connect a voltmeter between TP1 and TP2 on the main circuit board. Adjust R27 (5 kohm threshold adjustment potentiometer) until the voltmeter reads 50 mVDC.

8. Connect a GM or scintillation probe to the unit. Using an appropriate check source for the probe, observe that the unit operates properly on all four count rate ranges (i.e., that the unit detects probe activity). NOTE: make sure that the high voltage setting is acceptable for the probe being used prior to connecting the probe to the instrument.

9. Disconnect all test equipment. Complete, date, and sign the Certificate of Calibration.

TABLE T-1
Calibration with SW6 (Dead-time Compensation) OFF

Range	Pulse Generator Output (HZ)	Actual cpm	Acceptable Meter Reading (cpm)
X1000 (80%)	6667	400,000	360,000 -440,000
X1000 (20%)	1667	100,000	90,000 -110,000
X100 (80%)	667	40,000	36,000 - 44,000
X100 (20%)	167	10,000	9,000 - 11,000
X10 (80%)	66.7	4,000	3,600 - 4,400
X10 (20%)	16.7	1,000	900 - 1,100
X1 (80%)	6.7	400	360 - 440
X1 (20%)	1.7	100	90 - 110

Note: The values in the above tables may not correspond to those for other Bicron or competitive models.

Appendix B

Spare Parts List No. 1054911
Frisk-tech with Digital Scaler

Schematic Symbol	Description	Part No.
	Main PCB Assembly	1054010
C1	Capacitor, 4700uF, 25V, elec.	9224781
C2,C7,C12,C35,C36	Capacitor, 33uF, 16V, tant.	9233362
C4,C19,C32	Capacitor, .01uF, film	9211031
C5,C15,C16,C30,C31,C34	Capacitor, .1uF, film	9211041
C6,C27,C29	Capacitor, .047, film	9214731
C8,C9,C13	Capacitor, .001uF, 3KV, cer.	9201022
C10,C11	Capacitor, .01uF, 3KV, cer.	9201032
C14,C17	Capacitor, 150pF, cer.	9201511
C18,C28	Capacitor, .001uF, film	9211021
C23	Capacitor, .47uF, film	9214741
C24	Capacitor, 4.7uF, 10V, tant.	9234751
C25	Capacitor, 47uF, 10V, tant.	9234761
C26	Capacitor, 470uF, 10V, elec.	9224771
C37	Capacitor, 1uF, 35V, tant.	9231051
C38,C40	Capacitor, .001uF, N750, cer.	9201023
D1-D5	Diode, 1N4001	9600003
D6,D7,D12-D14,D16-D18	Diode, 1N4148	9600004
D8,D9	Diode, 2KV PIV	9600001
D10	Diode, 1N5234B	9600009
Q1,Q3,Q4,Q11	Transistor, 2N4124	9610001
Q2,Q8	FET, VN10KM	9610003
Q5	Transistor, 2N4126	9610002
R1,R21,R29,R34,R70,R74,R87	Resistor, 10K, 1/4W, 5%	8110024
R2,R8,R19	Resistor, 240 ohm, 1/4W, 5%	8124004
R3,R27	Trimpot, 5K, top adjust	9395023
R4	Resistor, 100 ohm, 1/4W, 5%	8110004
R5	Resistor, 6.2 ohm, 1W, 5%	8806281
R6,R17,R18,R20,R23,R24	Resistor, 1M, 1/4W, 5%	8110044
R7,R35,R71	Resistor, 100K, 1/4W, 5%	8110034
R9,R44	Resistor, 1.2K, 1/4W, 5%	8112014
R12	Resistor, 121K, 1/4W, 1%	8512134
R13,R73	Resistor, 470K, 1/4W, 5%	8147034
R14,R50,R53,R65	Trimpot, 50K, side adjust	9395031
R15	Resistor, 2.7K, 1/4W, 5%	8127014
R16	Resistor, 560 ohm, 1/4W, 5%	8156004
R22,R25,R86	Resistor, 20K, 1/4W, 5%	8120024
R26,R28,R36	Resistor, 274K, 1/4W, 1%	8527434
R31,R32	Resistor, 4.7K, 1.4W, 5%	8147014

Appendix B (cont'd)

Spare Parts List No. 1054911 (cont'd)
Frisk-tech with Digital Scaler

Schematic Symbol	Description	Part No.
R33,R51	Resistor, 10K, 1/4W, 1%	8510024
R45	Resistor, 10M, 1/4W, 5%	8510054
R46	Trimpot, 5M, side adjust	9395051
R47	Resistor, 1M, 1/4W, 1%	8510044
R48	Trimpot, 500K, side adjust	9395041
R49	Resistor, 100K, 1/4W, 1%	8510034
R52	Trimpot, 5K, side adjust	9395021
R55	Trimpot, 500 ohm, side adjust	9390511
R56	Resistor, 499 ohm, 1/4W, 1%	8549904
R60	Resistor, 750K, 1.4W, 1%	8575034
R61,R66	Resistor, 49.9K, 1/4W, 1%	8549924
R63	Resistor, 681 ohm, 1/4W, 1%	8568104
R72	Resistor, 4.7M, 1/4W, 5%	8147044
R76	Resistor, 1000M, 1%	8810071
R77,R78	Resistor, 499K, 1/4W, 1%	8549934
R85	Resistor, 1K, 1/4W, 5%	8110014
RN1	Resistor Network, 220K X 7	8822031
T1	Transformer, PSD4-28	9500003
T2	Transformer, M8149	9500001
U1,U2	Int. Ckt., LM317T	9640006
U4	Int. Ckt., CA5160BEX	9640001
U5	Int. Ckt., LM339AN	9640009
U6	Int. Ckt., MC14538BCPDS	9650004
U7	Int. Ckt., MC14093BCPDS	9650001
U8,U9,U12-U14	Int. Ckt., MC14016BCPDS	9650002
U10	Int. Ckt., LF351N	9640008
U11	Int. Ckt., ICL7660CPA	9640005
U15	Int. Ckt., MC14075BCPDS	9650031
	Header, 2 X 12 pin	9780017
	Header, AC power, 5-pin	9780068
	Header, 4-pin	9780069
	Switch PCB Assembly	1054020
C3	Capacitor, 33uF, 16V, tant.	9233362
C20	Capacitor, 4700pF, film	9214721
D11,D24	Diode, 1N4148	9600004
D23	LED, T-1 3/4, red	9680003
Q6	Transistor, 2N4124	9610001
Q7,Q10	Transistor, 2N4126	9610002
Q9	FET, VN10KM	9610003
R10,R75	Resistor, 240 ohm, 1/4W, 5%	8124004
R11	Resistor, 1.2K, 1/4W, 5%	8112014
R37,R40,R83	Resistor, 10K, 1/4W, 5%	8110024

Appendix B (cont'd)

Spare Parts List No. 1054911 (cont'd)
Frisk-tech with Digital Scaler

Schematic Symbol	Description	Part No.
R38,R82,R84	Resistor, 100K, 1/4W, 5%	8110034
R39	Resistor, 470 ohm, 1/4W, 5%	8147004
R41	Resistor, 16 ohm, 1/4W, 5%	8101604
R42	Potentiometer, 250 ohm, panel mount	9382511
R57,R59	Resistor, 1K, 1/4W, 5%	8110014
R58	Potentiometer, 25K, panel mount	9382532
R67	Resistor, 121K, 1/4W, 1%	8512134
R68	Trimpot, 50K, top adjust	9395032
R69	Resistor, 4.99K, 1/4W, 1%	8549914
SW2	Switch, rotary, 2 pole 3 position	9560014
SW3	Switch, rotary, 1 pole 7 position	9560009
U3	Int. Ckt., LM317T	9640006
	Sound Transducer	9720001
	Header, 2 X 12-pin	9780017
	Cable, 2 X 12-position	9801013
	Front Panel Subassembly (w/o scaler option, 1054140)	1054141
C106	Capacitor, 22pF, cer. (w/o scaler option, not required)	9202201
D19	LED, T-1 3/4, yellow	9680004
D101	LED, T-1, red (w/o scaler option, not required)	9680012
SW1	Switch, Power ON/OFF	9550006
SW4	Switch, Pushbutton (w/o scaler option, 9550009)	9550019
	Meter window	9400011
	Meter assembly (w/o scaler option, 9400005)	9400047
	LED lens, red	9680009
	LED lens, clear	9680017
	Connector, MHV (with BNC Connector option, 9782003)	9782001
	Rear Panel Assembly (w/o scaler option, 1054050)	1054051
SW102	Switch, rotary, 2 pole 3 position (w/o scaler option, not required)	9560016
	Receptacle, Line Cord	9760002
	Phone Jack, 3.5mm	9780022
	Connector, BNC	9782003

Appendix B (cont'd)

Spare Parts List No. 1054911 (cont'd)
Frisk-tech with Digital Scaler

Schematic Symbol	Description	Part No.
	Digital Scaler Option PCB Assembly (w/o scaler option, not required)	9420013
C101,C102	Capacitor, 22pF, cer.	9202201
C103	Capacitor, 33uF, 16V	9233362
C104	Capacitor, .01uF, film	9211031
C105	Capacitor, .047uF, film	9214731
D102,D103	Diode, Zener, 1N5231B	9600011
R101	Resistor, 10M, 1/4W, 5%	8110054
R102	Resistor, 470K, 1/4W, 5%	8147034
R103,R105	Resistor, 100K, 1/4W, 5%	8110034
R104,R107,R108	Resistor, 1K, 1/4W, 5%	8110014
R106	Resistor, 3.3M, 1/4W, 5%	8133044
R109	Resistor, 200 ohm, 1/4W, 5%	8120004
R110	Resistor, 4.7K, 1/4W, 5%	8147014
SW102	Switch, slide, 2 pole 3 position	9550010
U101	Int. Ckt., MC14011BCPDS	9650029
U102,U103	Int. Ckt., MC74HC4040NDS	9650009
U104	Int. Ckt., MC14093BCPDS	9650001
U105	Int. Ckt., ICM7240IPE	9650021
	6-digit LCD Counter/Display Module	9685001
	32.768 kHz Crystal	9729002
	Upper Housing Assembly	9100125
	Lower Housing Subassembly	1054170
	Miscellaneous	
BT1,BT2	Battery, 6V, 1A-hr rechargeable	9750005
F1	Fuse, 250V, 1/4A	9760001
	Knob, round, with pointer	9770001
	Knob, indicator	9770007
	Cable, MHV, 36" with strain relief	9801008
	Power cord, U.S.	9802001
	Documentaton	
	User's Manual	1054901
	Spare Parts List	1054911
	Schematic Diagram	1054920
	Schematic Diagram (scaler option)	9700225
	QC Acceptance Procedure	1054931

Appendix C

The drawings listed below follow this page.

Drawing Name	Number	Rev.
Schematic Circuit Diagram	1054920	B
Main PCB Assembly	9700223	-
Switch PCB Assembly	9700224	-
Schematic Circuit Diagram	9700225	B
Component Location Drawing, Digital Scaler Option	9700226	A

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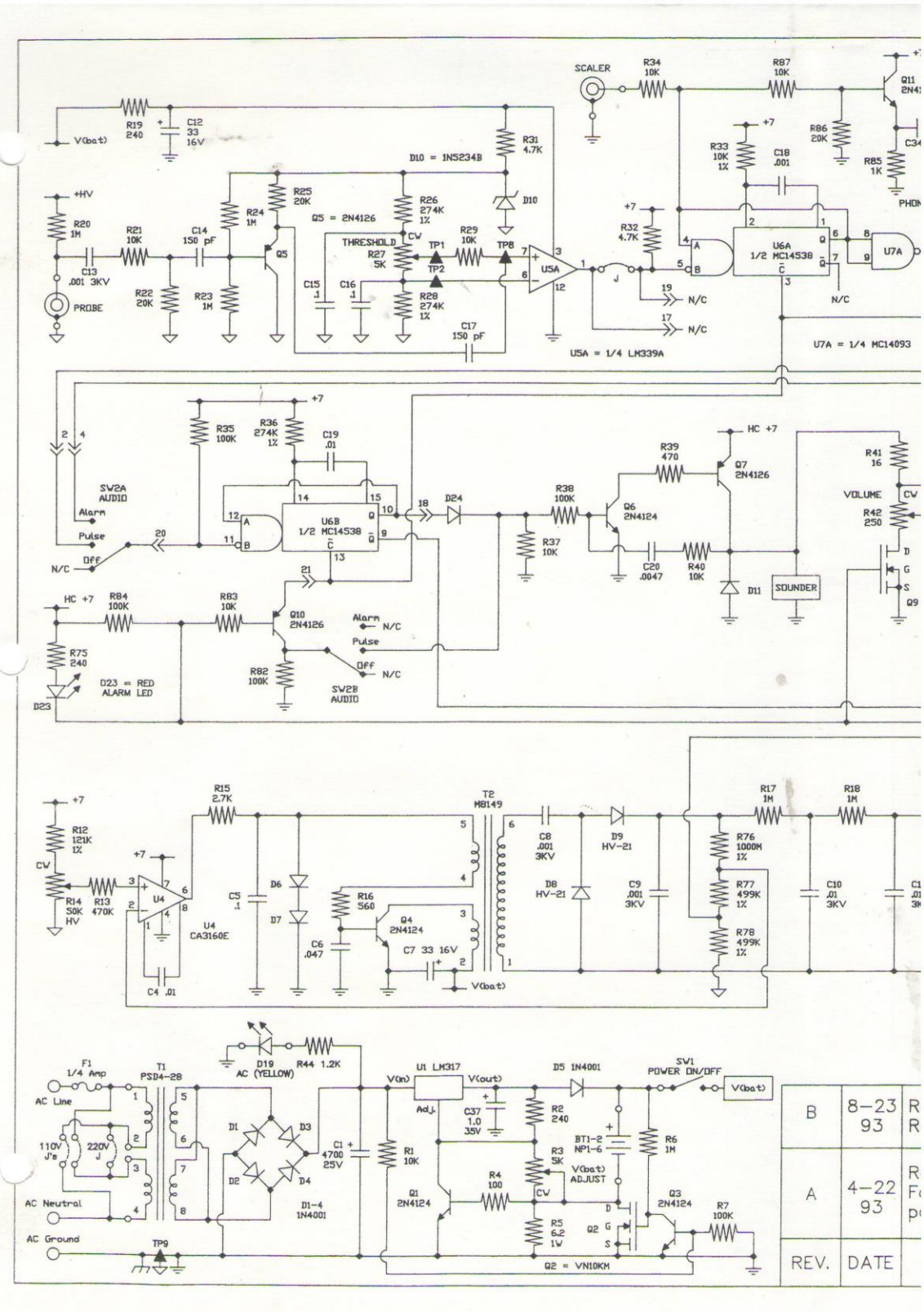
SCALER
R34 10K
R87 10K
Q11 2N4126
R19 240
C12 33 16V
V(bat)
D10 = 1N5234B
R31 4.7K
+HV
R20 1M
R21 10K
C14 150 pF
R24 1M
R25 20K
Q5 = 2N4126
R26 274K 1%
D10
THRESHOLD
R27 5K
CW
TP1
TP2
R29 10K
TP8
C13 .001 3KV
PROBE
R22 20K
R23 1M
C15 .1
C16 .1
R28 274K 1%
C17 150 pF
U5A
U5A = 1/4 LM339A
R32 4.7K
R33 10K 1%
C18 .001
R86 20K
R85 1K
U6A 1/2 MC14538
U7A
N/C
U7A = 1/4 MC14093
SW2A AUDIO
Alarm
Pulse
Off
R35 100K
R36 274K 1%
C19 .01
U6B 1/2 MC14538
D24
R38 100K
R39 470
Q7 2N4126
Q6 2N4124
R37 10K
C20 .0047
R40 10K
D11
SOUNDER
R41 16
VOLUME
R42 250
Q9
R84 100K
R83 10K
Q10 2N4126
R82 100K
R75 240
D23
D23 = RED ALARM LED
SW2B AUDIO
R15 2.7K
T2 M8149
R12 121K 1%
R14 50K HV
R13 470K
U4 CA3160E
C5 .1
C4 .01
D6
D7
C6 .047
R16 560
Q4 2N4124
C7 33 16V
C8 .001 3KV
D9 HV-21
D8 HV-21
C9 .001 3KV
R17 1M
R18 1M
R76 1000M 1%
R77 499K 1%
R78 499K 1%
C10 .01 3KV
F1 1/4 Amp
T1 PSD4-28
AC Line
110V J's
220V J
AC Neutral
AC Ground
TP9
D19 AC (YELLOW)
R44 1.2K
D1
D2
D3
D4
D1-4 1N4001
C1 4700 25V
U1 LM317
V(in)
V(out)
Adj.
C37 1.0 35V
R1 10K
Q1 2N4124
R4 100
R3 5K
CW
V(bat) ADJUST
R2 240
D5 1N4001
SW1 POWER ON/OFF
BT1-2 NP1-6
R6 1M
R5 6.2 1W
Q2
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B 8-23 93
A 4-22 93
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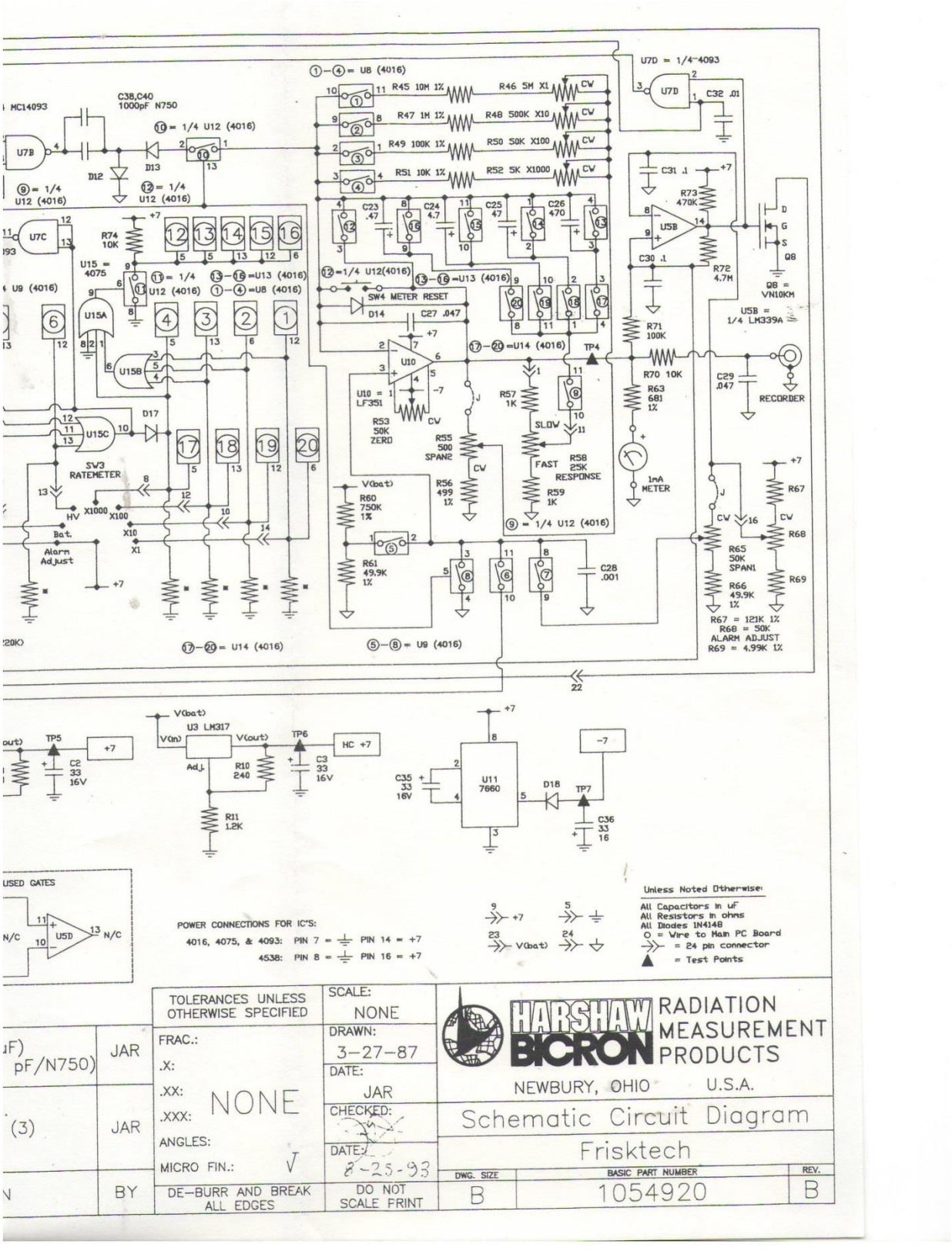

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			CHECKED:	Frisktech	
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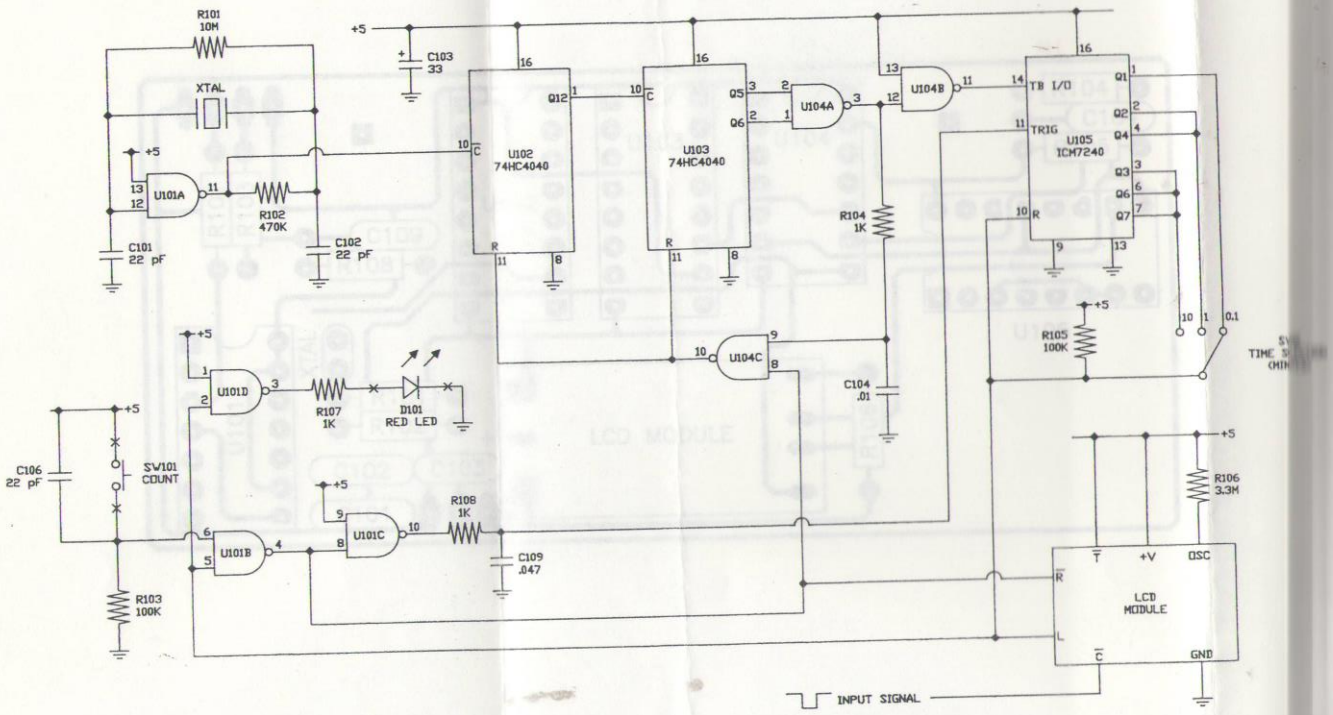

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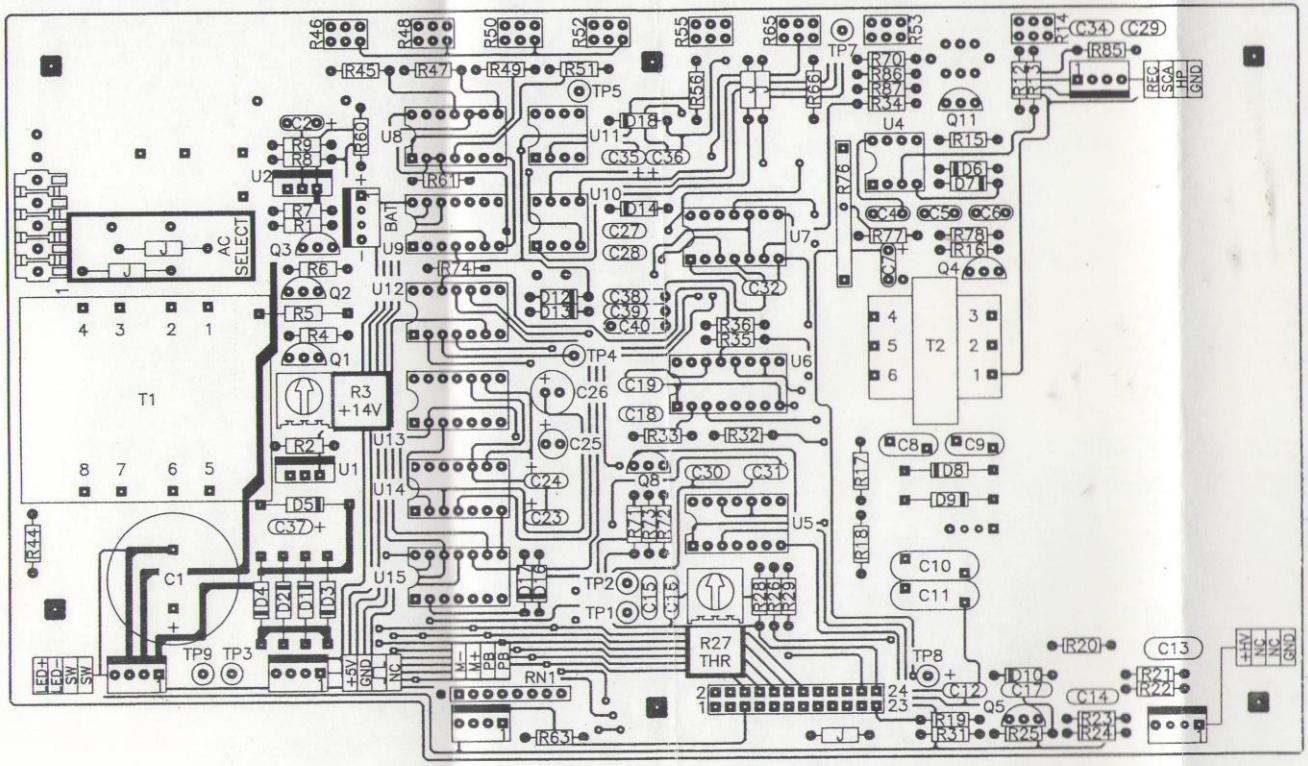

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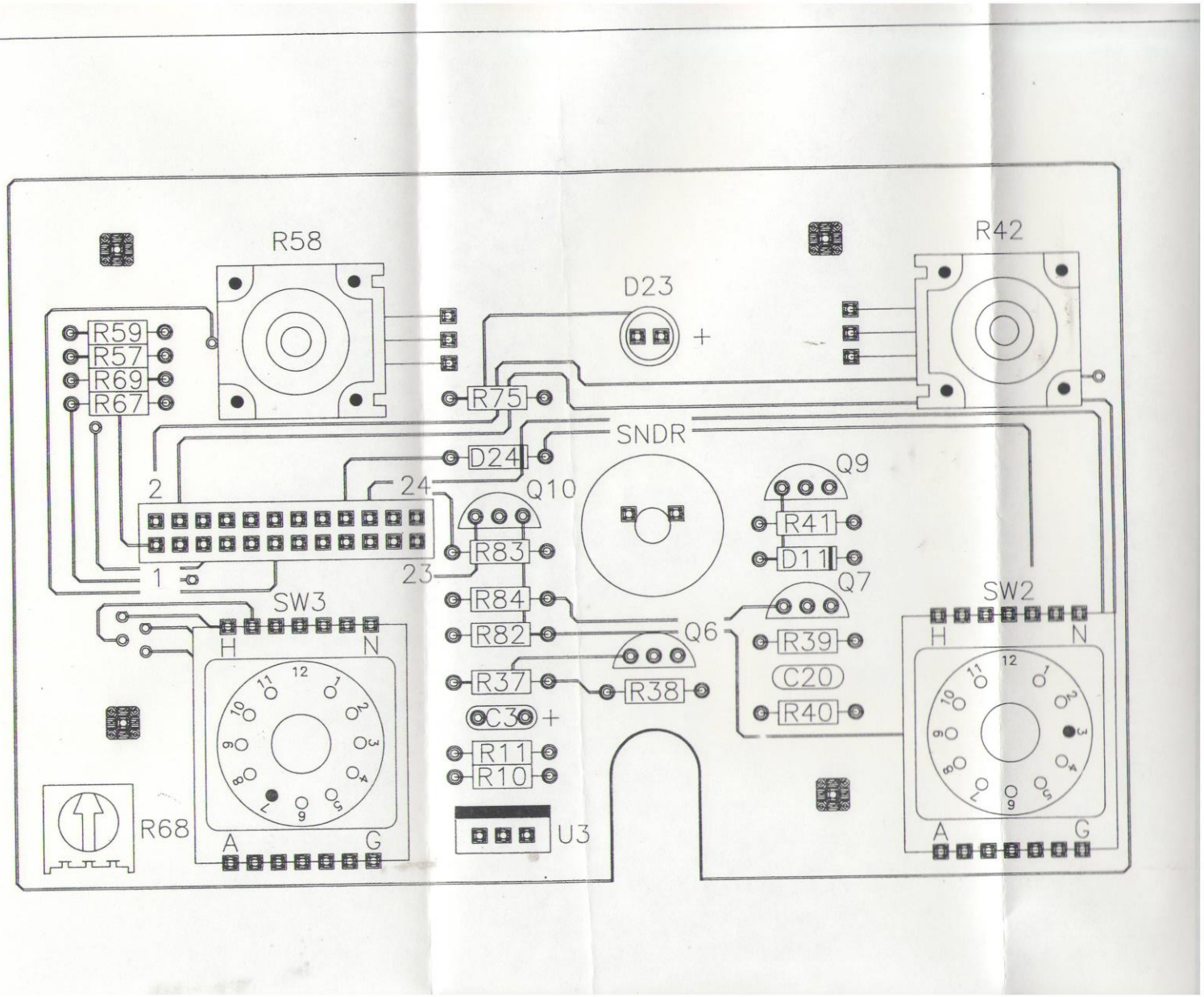
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R42
D23
R59
R57
R69
R67
R75
SNDR
D24
Q9
2
24
Q10
R41
D11
R83
1
23
Q7
SW3
SW2
R84
R82
Q6
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C30
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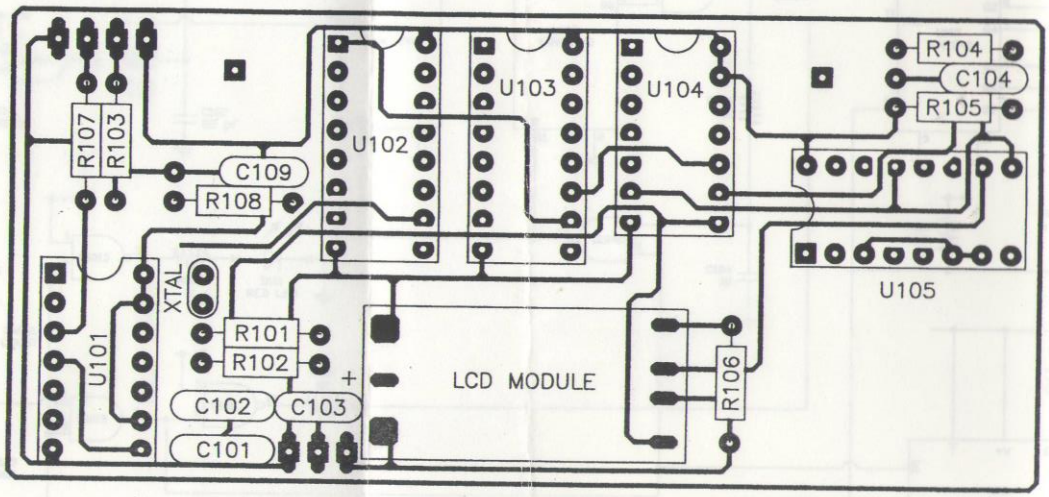
R104
C104
R105
U103
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C109
R108
U105
XTAL
U101
R101
R102
LCD MODULE
R106
C102
C103
C101